Catalytic Chemical Oxidation (Delphi DETOX)

Developer: Delphi Research, Inc.
Contract Number: DE-AC21-92MC29107
Crosscutting Area: ESP

Mixed Waste FOCUS AREA

Problem:

Many Department of Energy (DOE) sites contain complex and variable mixtures of hazardous organics, inorganics, and radionuclides which are difficult to remediate effectively. This is often compounded by their dispersal in soils, sludges, and water. Landfilling, incineration, and long-term storage techniques have been the traditional means of disposal of these wastes. Presently, new regulatory restrictions either prevent such techniques or make using them costly.

Solution:

The solution to this problem is the development and demonstration of a catalytic wet oxidation process for the treatment of multi-component wastes, with the potential to destroy hazardous organic compounds while containing and concentrating metals from contaminated materials. In laboratory studies, destruction efficiencies of this versatile treatment process have been greater than 99.9999% for oxidation of materials like xylene. This method may be used on a wide variety of waste types.

Benefits:

▸The chemical system is much more aggressive than most aqueous based processes and can treat more chemical compounds than wet oxidation at ambient conditions

▸The oxidant is continuously generated in solution and the reduced species form of the oxidant is an OH^- ion or water after neutralization in the acid solution; the heat input rate from oxidation of the organic materials is controlled by blending wastes to a fairly constant heating value

▸The process appears to have potential application to leaching of organic and inorganic contaminants from inert matrix materials which will not dissolve in the working solution and are not oxidized by ferric ion

▸Has been shown to destroy highly chlorinated compounds

▸Oxidation of organic contaminants with destruction efficiencies exceeding 99.9999% for some organic materials

▸Low treatment temperatures typically result in no production of NO_x, SO_x, dioxins, furans or volatile metals in the system off gasses

▸Low emissions make off-gas treatment and permitting requirements less complex than requirements for thermal treatment

▸The catalyst solution can accumulate toxic and/or radioactive metals until recovery or stabilization and disposal of metals is possible

Technology:

This process is based on a patented combination (DETOX^{SM}) of iron ions, a homogeneous oxidation catalyst, and a ferrous-iron to ferric-

iron oxidation catalyst in an acid solution to oxidize organic compounds. Laboratory studies have been conducted to measure the destruction efficiency of DETOX[SM] applied to several model organic compounds, evaluate the fate of eleven model metals in the DETOX[SM] solution, and determine the ability of DETOX[SM] to remove organics and metals from soils. The data obtained in these tests were used in a preliminary engineering study for a prototype treatment system. Design parameters were established to guide design of a prototype DETOX[SM] unit for the treatment of hazardous organics and metals from wastes.

The process has the potential to oxidize virtually all organic compounds and solubilize many metals. It could be of considerable use where there are mixed organics and metals in soils and sludges, landfill materials, extraction output streams, obsolete or decommissioned parts, or other matrices. In waste management, the process can have a variety of applications in treating Resource Conservation and Recovery Act (RCRA) wastes and in concentrating metals from waste streams for recovery.

Use of the process may offer a highly desirable reduction of public, occupational health, and environmental risks by removing the waste or converting it to a form which in many cases is of less volume and toxicity, may be at least partially reclaimed, and/or can be treated as a radioactive waste. Operations can be improved by treating a variety of waste types, thus simplifying the task of waste handling, segregation, characterization, and treatment.

Cost reductions could result from the relatively low-cost treatment with this process, particularly in the case of multi-component waste mixtures and mixed wastes, and from the consolidation of waste treatment from a variety of wastes into one process rather than a number of separate systems.

The process can reduce the time required for remediation by treatment of wastes to eliminate them at the site, thus saving considerable time in attempts to accomplish long-term site extraction, stabilization, monitoring, and management. While the process is not solely a waste-volume minimization technique, it can allow considerable volume reduction of radioactive wastes by destruction of the organic portions with resultant containment and concentration of the radionuclides.

Contacts:

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DOE's Federal Energy Technology Center supports the Environmental Management - Office of Science and Technology by contracting the research and development of new technologies for waste site characterization and cleanup. For information regarding this project, the DOE contact is:

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